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tainly it is not so presupposed by a pragmatism that interprets the term, "practical" "in the narrow sense." Mere utility will not inevitably drag along the implication relation. But wherever statements are made that ideas are true because they "work," because they successfully "lead" to other ideas and to other realities,—there we are simply listening to descriptions of the implication relation in certain concrete manifestations. For that one thing can imply another means nothing more than that things go together in our experience; and hence that one thing may "lead" to the other. And without this implication, this togetherness, all value would fade into nothingness.

EDMUND JACOBSON.

CAMBRIDGE, MASS.

ON METHODS AND METHODOLOGY

THE science of methodology has, for many years, been recognized as a branch of logical theory, but, concerning its objects and its methods there appears to be neither general agreement nor clear discussion. It is universally asserted among philosophers that there is a body of knowledge called science, that this has been obtained by a certain vaguely defined scientific method, and that this method should not be ignored in the elucidation of logical theory; but here agreement seems to end. Since the period of Mill and Bain, the results of the study have been meager. The study appears to have become entangled with metaphysical subtleties and to have been barren of definite conclusions which have any recognizable bearing on the sciences from which they have been abstracted. The errors of the old empirical writers have been discovered and pointed out, but no clear and useful conclusions appear to have taken the place of those which have been criticized and abandoned.

This barrenness appears to me to be due to the fact that modern logicians have been largely occupied with the metaphysical foundations of their science, and so have lost touch with the scientific methods which form the rightful subject-matter of their study. The present barrenness and indeterminateness points to the conclusion that a valid and fertile methodology should proceed by the empirical rather than by the metaphysical method.

It is instructive to note that a similar conclusion has been reached by another course of reasoning. This line of thought is best illustrated by some of the views of Professor Dewey. In a criticism of some contemporary logical theory he remarks that "Logical theory will get along as well as reflective practise when it sticks close by and observes the directions and checks inherent in each successive phase of the evolution of the cycle of experiencing. The problem in general of the validity of the thinking process as distinct from the validity of this or that process arises only when thinking is isolated from its historical position and its material context."[1]

The above striking quotation, which I have removed from its context (and with the context of which I must not be understood to express full agreement) well illustrates the standpoint of the present essay. The value of philosophical controversies is often found in the truths which emerge incidentally rather than in any considerable addition to our knowledge of the topics nominally under discussion. In the present instance, whatever opinions we may hold concerning unsettled logical controversies, the view expressed above is one that well deserves careful thought.

The discussion of the metaphysical nature of judgment and of its relation to reality, which forms so large a part of some modern logical theory, has no doubt considerable value from a certain point of view. But, from the standpoint of the objective philosopher, it is more important to distinguish clearly between good judgment and bad judgment. The degree of abstraction in the more abstruse discussions is too great to be of practical use in assisting us to evaluate the logical processes involved in the actual work of positive science.

Without insisting too dogmatically on this view so far as it relates to pure logic, or attempting to limit the methods which may conceivably be used by theoretical logicians in such inquiries, it will be sufficient for me to point out that whatever cogency such remarks may possess in their relation to logic, is vastly increased when we apply them to methodology.

The process of thought is as old as mankind, and, in its rudiments, is probably a faculty inherited from our primeval ancestry in the remote geologic past long before the species man could be said to exist. Certainly more than traces of the thought process are to be found in the higher animals, and, consequently, a subjective analysis of the thought process will have as its subject-matter a mass of ingrained hereditary material. While reasoning that can truly be called logical is not of such remote antiquity, yet it is universal among mankind. Observers of the most backward savage races or of the very youngest children who have acquired the power of speech are often astonished at the penetration displayed in actual practical inferences when the subjects discussed are of such a nature as to form a real part of the experience of the individuals concerned. While children and savages would not express their ideas in syllogistic form, it would be idle to deny the applicability of the term logical to any process of thought by means of which it is possible habitually to advance from valid premises to correct or even to plausible conclusions. Indeed, it can surely be accepted as a fact of history, independent of all theory, that a vast amount of logical thinking in the concrete must precede the development of a science of logic in the abstract worthy of the name.

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[1] "Studies in Logical Theory," p. 62. The present essay is in no way concerned with the relation of metaphysics and logic or with the theories of Lotze and others which Professor Dewey criticizes; but it strongly maintains the necessity of removing methodology from the metaphysical to the practical side of logical theory.

The application of this conception to methodology is obvious. While reason is universal among mankind and can, therefore, be inferred to have descended from a remote antiquity, that development of the process of human thought which can rightfully be described as scientific investigation is of comparatively recent origin. No doubt the first rough principles are implicit in all correct observation and logical thinking. Germs of the method and some of its practical results can be traced to the dawn of history. The primitive steam-engine of Hero of Alexandria, the universal fame of Archimedes and the principles with which his name is associated are two prominent examples. Yet, there is no evidence that any such investigations had advanced beyond the earlier stages when their development was not great enough to supply material for a special branch of logical theory.

For all practical purposes, we can trace the rise of any considerable body of scientific investigation to the sixteenth and seventeenth centuries. This development having existed during so brief a period, it is evident that there is an enormous antecedent improbability against the assumption that, by a metaphysical method, or by an examination of the thought process as such, it is possible to deduce valid principles of methodology. In this region of thought it is also clear that there is a special danger in too great abstraction. When the process is carried too far, the results are liable to lose any intelligible connection with the particulars from which the abstractions have been made.

Examples of this tendency can be seen when intellectualist logic touches the borders of methodology. One striking instance is seen in the modern treatment of cause and effect, concerning which the conclusion of one school of theorists is concisely expressed by Professor Bosanquet, who identifies this relation with ''complete ground.''[2]

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[2] See "Logic the Morphology of Knowledge," Vol. I., p. 276. "Now it is plain from what has been said that the distinction of cause and effect is self-destructive. It is utterly impossible to be successful in the investigation of a

It is outside the scope of this essay to enter into a full discussion of the idea of cause or of the elimination from it of the time element; but, without entering into metaphysical reasoning, it will well illustrate the standpoint of this thesis to examine its meaning with regard to science. If "complete ground" be regarded from one point of view, it may be interpreted as a very indirect assertion of the ultimate unity of nature and of the principle that no phenomenon or section of phenomena is in reality isolated, but all take their place in the greater cosmic unity. If it means this, it asserts a principle that few, and certainly not I, are concerned to deny, and it is only open to criticism in that the method of stating it is confusing and entangled with much unnecessary controversy. If, on the other hand, it is intended to be of any practical value in science or in methodology it can readily be seen that it fails to accomplish this object.

The scientist, for the purposes of his actual investigations, is by no means concerned with the nature of cause as such (if indeed the degree of abstraction in such a conception is not so great as to have taken from the term all concrete meaning), but of the interrelation of particular causes and particular effects.

It is the essence of the scientist's conception of cause that it is not complete ground, that it is possible to repeat in time certain conditions which we call causes and obtain thereby certain other conditions which we call effects. A scientist finds by experiments that one specimen of nitrogen which he obtains from the air is heavier than another which he obtains from nitrites. The cause of this is not "complete ground" (which is equivalent to saying that the experiment can not be repeated), but the presence of argon in the air. After a long period of careful research, this particular "cause" of the observed effect is discovered. It is in the unraveling of particular conditions such as these that the phenomenal advance of science has come about, and it is only in so far as methodology can throw light on the character of such interrelations that its treatment of cause or of any other scientific conception has any meaning or value in connection with the sciences from which it has been abstracted.

causal relation without reducing it to the intelligible unity of a complete ground." It is obvious in a case of this kind that immediately the relation becomes reciprocal (complete ground) it becomes identical and we obtain the tautology air = air or argon = argon. And so long as we retain the incomplete relation heavy nitrogen we do not necessarily imply argon. Any event that can be repeated in time is necessarily incomplete ground or "concrete events or groups of incomplete relations" (*ib.*, p. 268), and if we advance beyond this to Professor Bosanquet's intelligible unity we reach a sphere where scientific investigation has no meaning. The metaphysical unity we then obtain is an assumption which antecedes the whole investigation. In short, such a treatment of cause has no bearing on scientific work.

The kind of methodology which we may call abstract maintains its relation to the metaphysics from which it has been obtained, but it has lost its connection with science. Such methods as these do not assist scientific investigation, they only occasion confusion. To this kind of investigation the scientist gives a very effective reply by ignoring it altogether, and the quality of his work does not appear to suffer in consequence. Whether or no the metaphysical treatment of methodology be theoretically possible, it seems not unlikely that other lines of treatment may give more practical results. Even if in a remote future it be possible to carry the process of abstraction to a higher degree, yet, for the present, we require a more careful and detailed study of methods in particular and a wider area of data on which to build our generalizations.

The conclusion of this line of argument obviously points to the desirability of reverting to a more empirical treatment, and to the methods of the great founders of inductive logic and scientific methodology. While some of the special ideas of Mill and the other empiricists are open to criticism in detail, there can be no doubt that in their close adherence to actual instances of scientific investigation, in their abstraction of methods from real researches in which they had been used, they discovered an invaluable instrument of research. In the use of this instrument, modern methodologists must not shirk the task of criticizing, and where necessary criticizing adversely, the methods used by the scientist and the manner in which he applies them. Here is a difference between the standpoint of the early methodologist and that which should be adopted by his successors.

In the early stages of the science it was necessary to find some universal starting-point and this was obtained by the analytical examination of processes of investigation which were clear and straightforward. But, after the first results have been gleaned in this manner, there is a danger that further conclusions concerning method, drawn from researches where there is no possibility of difference concerning methods or results, should be of the nature of truisms. No doubt there are still interesting problems of methodology implicit in the analysis of researches on the formation of dew or in the theories of induced electricity, but such do not lie on the surface. At any rate, there should be possible a new kind of methodological investigation which maintains an even closer relation between theory and practise. Such an investigation will endeavor to distinguish between valid and invalid methods in their application to actual problems, and, from instances of their use and misuse, to exhibit the main principles which underlie them.

Some attempts have already been made by philosophers to accomplish these more practical aims. The recognized distinction between the individual and the statistical methods is a case in point. Owing to philosophic criticism, no one, outside the sphere of popular journalism, would maintain that so many people must commit suicide in London or New York every year. Such a work as the second volume of Sigwart's "Logik" contains many cogent criticisms of the valid and the invalid application of scientific method. But, as a rule, such investigations are somewhat remote from the actual theories of the contemporary scientist. Standard works tend too much to assume the form of a dictionary of theory. They are ignored by the scientist, who most needs their help, and by the philosopher they are studied without sufficient regard to concrete application.

An attempt to establish a closer relation between theory and practise will be found in my own "Principles of Applied Mathematics," an essay which originated entirely from a study of the problem of secular cooling. That any scientist of note, much less the great Lord Kelvin, should have put forward as probable fact, a theory of geologic time which contained so many patent fallacies, appeared to me so strange that I endeavored to discover the reason. It was soon apparent that the mathematical physicist was hypnotized by the form of his mathematical instrument and that he failed to inquire where it was and where it was not applicable. My own article was an attempt to place this matter on a sound theoretical footing.

This, I am sure, is not the only case where such investigations are possible, and I sincerely hope that similar work will be undertaken by other philosophic writers. The scientist will then find that he can not ignore the philosopher, and the philosopher will discover that he has a rightful sphere a little nearer earth than he has been accustomed to look. Wherever methodology may end, it is here that it should begin.

For such work as this, the rise of modern specialism offers many opportunities. In recent scientific investigation, the range of the individual worker has tended to become so narrow, and his outlook over the main field of science so limited, that errors are continually liable to occur in the application of the results of one branch of knowledge to another. The mathematician dogmatizes over the whole field of cosmological speculation. The biologist makes unproved and far-reaching assertions concerning the methods of evolution which affect our ideas on the nature of man and of society. In all branches of science and in all fields of knowledge this is the age of the specialist.

In the careful examination of the methods of the special sciences, in the determination of their nature and of their necessary limits will be found a large and fertile field for the investigation of the methodologist.

H. S. SHELTON.

ASHFORD, MIDDLESEX, ENGLAND.

CONTINGENCY IN AN INFINITE WORLD

IN the number of this JOURNAL for February 3, 1910, Mr. W. H. Kilpatrick champions the thesis that "if the actual universe be conceived as quantitatively infinite," definite and final determination "antecedent to the act of eventuation" is excluded. The event on arrival is, indeed, the inevitable outcome of the actual conditions, but in an infinite universe it can never be inevitable—that is, predictable by an adequate intelligence—before it arrives. *A priori* it is necessarily contingent, since the most perfect deduction is necessarily made subject to the proviso that the conditions remain unchanged. This is what can never be guaranteed in an infinite world, a quantitative infinity offering endless possibilities of new factors appearing in the field of even the most perfect calculation.

The question raised is evidently purely speculative. All actual human prediction is, of course, contingent; but Laplace and his followers have been wont to maintain that for a conceivable superhuman intelligence the future, and indeed all time to its smallest details, would be an open book; or, better, a mathematical formula capable of making infallible disclosures without limit in the past and the future. Mr. Kilpatrick denies this speculative possibility on the ground that it requires the postulation of a closed and finite universe, which is "substantially different from what science assumes our actual universe to be."

But in what sense does science assume the universe to be infinite? Mr. Kilpatrick indicates the correct answer when he explains that he uses "the word infinite . . . in the mathematical sense, to indicate, that is, such a variable number as may surpass any arbitrarily assigned number, however great." At this point difficulty appears, for such an infinite is essentially a positive and not a negative term; it is in itself a perfectly definite quantity. However much it may transcend human grasp and be "infinite" relative to human capacity, it is for the superhuman calculator of Laplace a finite quantity; and it does not appear why such an intelligence should not deal with it successfully, and, if not otherwise hindered, compute with entire accuracy and in utmost detail the whole course of events. Nor is any true infinite regress involved in the consideration of the